

## CLAIMS

- 1 1. A vibrational energy harvester that converts mechanical vibrations into electrical  
2 energy, comprising:  
3 a magnetic field source that generates a magnetic field;  
4 a magnetic field sensing element including a layer of magnetostrictive  
5 material having a magnetization vector that responds to variations in the  
6 magnetic field by generating a stress, a layer of electroactive material,  
7 mechanically bonded to the layer of magnetostrictive material, that responds to  
8 the stress by generating a voltage; and  
9 means for mounting the magnetic field source and the magnetic field  
10 sensing element so that the vibrations cause the magnetic field source to move  
11 relative to the magnetic field sensing element.
- 1 2. The vibrational energy harvester of claim 1 wherein the magnetostrictive material  
2 has a magnetization vector that responds to variations in the magnetic field by  
3 rotating in a plane and wherein the magnetic field sensing element includes  
4 electrodes that measure the voltage generated by the electroactive material in a  
5 direction substantially parallel to the plane in which the magnetization vector  
6 rotates.
- 1 3. The vibrational energy harvester of claim 1 wherein the magnetic field sensing  
2 element further comprises a second layer of magnetostrictive material bonded to  
3 the layer of electroactive material, the second layer of magnetostrictive material  
4 having a magnetization vector that responds to variations in the magnetic field by  
5 generating a stress.
- 1 4. The vibrational energy harvester of claim 3 further comprising a flux closure yoke  
2 comprised of magnetic material that reduces the reluctance of a magnetic circuit

3 between the first and second magnetostrictive layers and spans the electroactive  
4 layer.

1 5. The vibrational energy harvester of claim 3 wherein the magnetic field source  
2 comprises a pair of permanent magnets.

1 6. The vibrational energy harvester of claim 5 further comprising a flux closure yoke  
2 comprised of magnetic material that completes a magnetic circuit between the  
3 pair of permanent magnets.

1 7. The vibrational energy harvester of claim 1 wherein the magnetostrictive layer is  
2 disk-shaped.

1 8. The vibrational energy harvester of claim 7 wherein the means for mounting the  
2 magnetic field source and the magnetic field sensing element is adapted so that  
3 the vibrations cause the magnetic field source to rotate relative to the magnetic  
4 field sensing element.

1 9. The vibrational energy harvester of claim 8 wherein the vibrations can be  
2 resolved into orthogonal, linear motions and wherein the vibration energy  
3 harvester further comprises an inertial mass attached to one of the magnetic field  
4 source and the sensing element causing the magnetic field source and the  
5 sensing element to rotate relative to each other in response to the vibrations.

1 10. The vibrational energy harvester of claim 8 wherein the mounting means is  
2 adapted so that both the magnetic field source and the magnetic field sensing  
3 element rotate in response to the vibrations.

- 1 11. The vibrational energy harvester of claim 1 wherein the magnetic field source  
2 comprises a first pole piece and a second pole piece and wherein the magnetic  
3 field sensing element is positioned between the first and second pole pieces.
- 1 12. The vibrational energy harvester of claim 11 wherein each of the first and second  
2 pole pieces comprises a plurality of magnets arranged in opposing flux  
3 relationship.
- 1 13. The vibrational energy harvester of claim 12 wherein the first and second pole  
2 pieces are arranged so that the magnetic flux pattern in the vicinity of the  
3 magnetic field sensing element comprises alternating bands of opposite field  
4 directions.
- 1 14. The vibrational energy harvester of claim 13 wherein multiple field sensing  
2 elements are located between the first and second pole pieces.
- 1 15. A vibrational energy harvester that converts mechanical vibrations into electrical  
2 energy, comprising:  
3 a magnetic field source that generates a magnetic field;  
4 a magnetic field sensing element including a first disk-shaped layer of  
5 magnetostrictive material having a magnetization vector that responds to  
6 variations in the magnetic field by generating a stress, a layer of electroactive  
7 material, mechanically bonded to the first layer of magnetostrictive material, and  
8 a second disk-shaped layer of magnetostrictive material bonded to the  
9 electroactive material layer and having a magnetization vector that responds to  
10 variations in the magnetic field by generating a stress so that the electroactive  
11 layer that responds to the stresses generated by the first and second  
12 magnetostrictive layers by generating a voltage; and

13 means for mounting the magnetic field source and the magnetic field  
14 sensing element so that the vibrations cause the magnetic field source to rotate  
15 relative to the magnetic field sensing element.

1 16. The vibrational energy harvester of claim 15 wherein the electroactive layer is  
2 disk-shaped having a first and second planar faces and the first magnetostrictive  
3 layer is bonded to the first planar face and the second magnetostrictive layer is  
4 bonded to the second planar face.

1 17. The vibrational energy harvester of claim 16 wherein the first and second planar  
2 faces are circular.

1 18. The vibrational energy harvester of claim 16 wherein the first and second planar  
2 faces are elliptical.

1 19. The vibrational energy harvester of claim 15 wherein the electroactive layer is a  
2 rectangular solid having first and second planar faces that are rectangular.

1 20. The vibrational energy harvester of claim 15 wherein the electroactive layer is  
2 disk-shaped with two disk-shaped faces and a cylindrical outer surface and  
3 wherein the vibrational energy harvester further comprises a pair of electrodes  
4 attached to the cylindrical outer surface.

1 21. The vibrational energy harvester of claim 20 wherein each electrode has an arc  
2 length of between  $1/8$  and  $3/8$  of the circumference of the cylindrical outer  
3 surface.